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(54) System and procedure for the control of the antenna of a mobile radio telephone network

(57) System for the control of single antennae or antenna arrays (1) of a mobile radio telephone network, which are installed on fixed bases (2) through a couple of supports (10, 11) rotating around a substantially horizontal axis and a substantially vertical axis, in which the form and dimensions of the coverage field (4) of each antenna (1) depend on the vertical pointing angle (ϑ) and on the horizontal pointing angle (φ). This system includes at least one central electronic processor connected through bi-directional lines (20) to a plurality of peripheral electronic processors (17) connected in their turn through bi-directional lines to one or more servomechanisms (13, 15) installed on said fixed bases (2), in which the mobile component of one of said servomechanisms (13, 15) is cinematically coupled to one of said supports (10, 11) of the antennas (1) and is operated by an actuator (e. g. a reduction gear) according to electrical signals transmitted by said central electronic processor through said peripheral processors (17), said electric signals corresponding to the variation of the vertical pointing angle (ϑ) and/or of the horizontal pointing angle (φ) of the antennas (1) themselves. The present invention relates also to a control procedure implemented through said system.

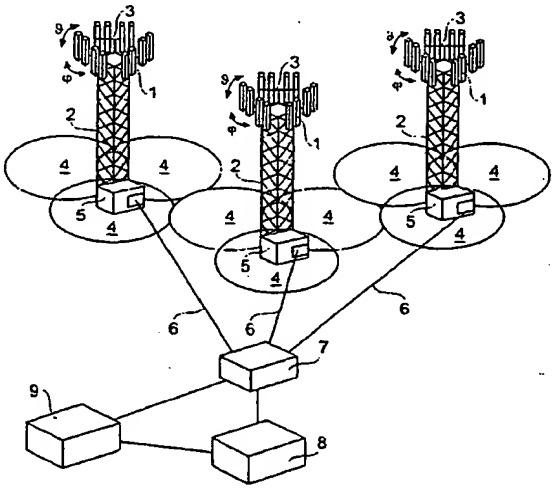

Fig.1

EP 1 014 482 A2

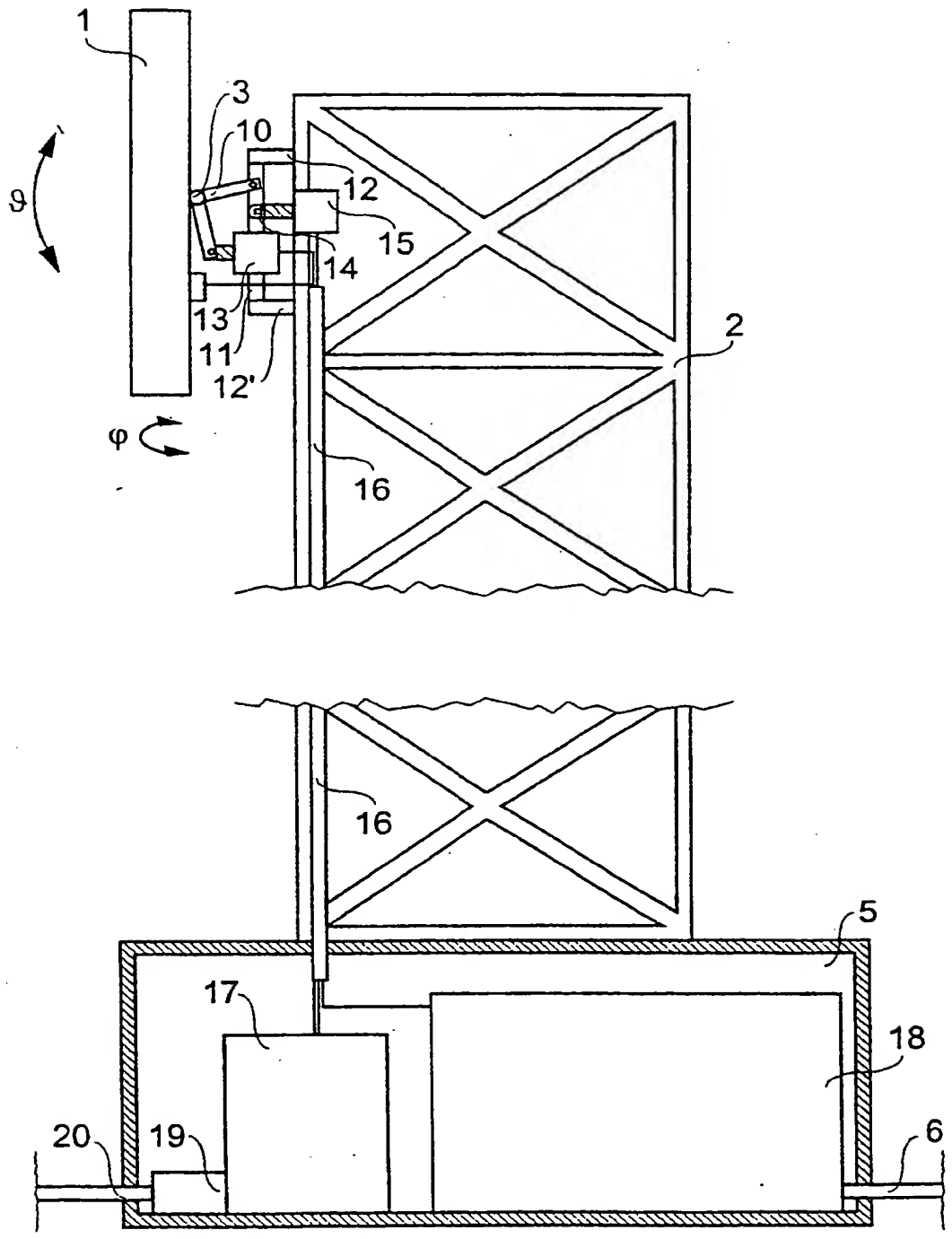

Fig.2

Description

Field of the Invention

[0001] The present invention relates to a system for the control of the antennas of a mobile radio telephone network, and in particular to a system enabling to check the orientation and other antenna operation parameters to the purpose of adapting their coverage field on the basis of possible variations of operating conditions of the network itself. The present invention relates also to a control procedure realized through said system.

[0002] It is known that a mobile radio telephone network, in particular cellular telephone communication, includes a plurality of towers spread on the territory, on which some antennas are installed, generally subdivided into three groups of four antennas each. Said antennas are arranged according to an orientation suitable to the best coverage of the territory surrounding each tower, for instance with an horizontal pointing angle reciprocally phase shifted by 120° for each one of the three groups of antennas.

Background art

[0003] This orientation, as well as other parameters governing the operation of the antennas, such as for instance the transmission power and the width of the lobe of the radiated field, are determined on the basis of the characteristics of the surrounding territory, such as the population density, the orography, the presence of artificial obstacles, etc. The determination of these parameters is implemented through sophisticated and complex procedures with the aid of electronic simulation and measuring instruments of the network in real conditions. Moreover, these procedures have recourse to the particular know-how acquired in the time by the network designers, who become constantly aware of service priorities, information supplied by the users, progress of the plants, etc.

[0004] Therefore, it is evident that following the variation of the network operation conditions, for instance due to the installation of a new tower with antennas or a localised increase of telephone users, it is necessary to re-set the above mentioned antenna operation parameters in one or more towers.

[0005] In particular, to change the horizontal and vertical pointing angles of the antennas it is necessary that teams of skilled operators perform works of mainly manual character on the top of said towers, with consequent obvious risks for the safety of the same, as well as high execution costs, difficulty in the control of the correct operation and identification of possible operational mistakes. These drawback concur to limit the number of variation operations to the minimum absolutely necessary extent and therefore impose some restrictions to the best configuration of the network.

Objects of the Invention

[0006] Object of the present invention is to eliminate the above mentioned drawbacks through a system enabling to change in a simple and quick manner the antenna operation parameters, in particular their orientation.

Summary of the Invention

[0007] Said object is attained through a system and a procedure whose main characteristics are specified in the first and the eighth claim, respectively.

[0008] Thanks to the network of electronic processors and servomechanisms it is equipped with, the system according to the present invention allows to automatically check the operation parameters, and in particular the orientation, of all the antennas of a mobile radio telephone network, so to considerably reduce both the times and the complexity of the control and of the possible modification of parameters following changed operation conditions of the network.

[0009] In fact, through the system according to the present invention it is possible to check from one sole site all the antennas of the network, even if placed at a very large distance from said site, with clear advantages as for the simple use of the system and resource optimization .

[0010] Furthermore, the system according to the present invention shows the undoubted advantage to be applied without particular problems to already existing mobile radio telephone networks, availing, where possible, of all the structures already installed and operating on the territory.

Brief description of figures

[0011] The invention, together with further objects and advantages thereof, may be understood by those expert in the field, taken in conjunction with the accompanying drawings, in which:

- figure 1 shows a partial schematic view of a mobile radio telephone network including the system according to the present invention; and
- figure 2 shows a partial lateral view of a tower of the network shown in figure 1.

Detailed description of a preferred embodiment of the Invention

[0012] Making reference to figure 1, it can be noticed that a mobile radio telephone network includes in a known way a plurality of antennas 1 for the reception and/or transmission of radio signals, installed on the tops of towers 2 or other high buildings, which are generally subdivided into three groups of four antennas, oriented according to three horizontal axis, reciprocally

sloped by 120°.

[0013] Without departing from the scope of the present invention, obviously it results possible to use single antennas, or pairs of antennas, for instance to implement the so-called reception in space diversity, or an array of antennas for each group as shown in the figure.

[0014] The antenna 1 of each one of the three groups of four antennas are fixed according to parallel axis to an horizontal cross bar 3 and project on the ground a coverage field 4 whose form and extension depends on the vertical pointing angles ϑ and on the horizontal one φ, as well as on other operation parameters, in particular, transmission power and width of the lobe of the field radiated by each antenna.

[0015] Close to the base of each tower 2, a local control station 5 is located, commonly called from English BTS *Base Transceiver Station,* which includes a plurality of electrical and electronic equipment for the control of the operation of antenna 1 and of the flow of signals received and/or transmitted by the same. The base transceiver stations 5 are in their turn connected through a network of telephone lines 6 to a plurality of base station controllers 7, commonly called BSC from English *Base Station Controller,* which perform the control of the base transceiver stations 5 connected to the same. Finally, one or more base station controllers 7 are connected to a switching centre 8, commonly called MSC from English *Mobile Switching Center,* which performs the connections with additional telephone lines, in particular with the fixed telephone network. All the base transceiver stations 5 and geographical ones 7, as well as the mobile switching center 8, are connected to an operating maintenance center 9, commonly called OMC from English *Operating-Maintenance Center,* in which all the information relevant to the operation of the mobile radio telephone network are gathered.

[0016] Making now reference to figure 2, we notice that the cross bar 3 of each group of antennas 1 is fixed to an angular support 10 pivoted at the top of a vertical shaft 11, which is installed in its turn in a pivoting way between two supports 12, 12' integral with the tower 2. Therefore, each antenna 1 can be rotated in horizontal direction according to an angle φ and vertically sloped according to an angle ϑ.

[0017] The free end of the angular support 10 is adequately pivoted at the end of a first threaded rod, which is operated in the longitudinal direction by an actuator preferably consisting of an electrical reduction gear of a servomechanism 13 fit with sensor of the digital type, capable to detect the correct position of said tale threaded rod. The free end of an horizontal rod 14 integral with the vertical shaft 11 is also pivoted on the end of a second threaded rod, it too operated in longitudinal direction by an electrical reduction gear of an additional servomechanism 15 fit with digital sensor capable of detecting the correct position of said second threaded rod.

[0018] Through lines placed inside a vertical conduit 16, a peripheral electronic processor of the known type 17 located in the base transceiver station 5 transmits the control electrical signals for the operation of the electrical reduction gears of servomechanisms 13 and 15. The peripheral processor 17 receives also the position signals transmitted by the sensors of servomechanisms 13 and 15 through additional electrical lines contained in the conduit 16, which contains also the lines carrying the signals transmitted and received by antennas 1 to the power unit 18 connected to lines 6 of the telephone network. Through additional lines placed in the conduit 16, the peripheral processor 17 transmits also the electrical control signals of the transmission power and of the width of the lobe of the radiated field to the antennas 1. The peripheral processor 17 includes in particular a modem 19 connected to a telephone line 20, which preferably does not belong to the group of lines 6, but is directly connected, for instance through a dedicated telephone line, to an additional modem of a central electronic processor (not visible in the figure) placed in the operating maintenance center 9.

[0019] In the use, the central processor of the operating maintenance center 9 periodically interrogates the peripheral processors 17 of all the control stations of the network. This interrogation procedure includes in particular the transmission through the line 20 of a predefined code, which determines the enabling in the peripheral processor 17 of a program reading the position of the threaded rods of each servomechanism 13 and 15 through the relevant digital sensors. The program of the peripheral processor 17 reads also the other antenna operation parameters 1 and sends all the values read to the central processor through the line 20.

[0020] Once the position of the threaded rods is received together with the operation parameters of all the antennas of the network, the central processor calculates, on the basis of initial values stored in the memory it is fit with, the vertical and horizontal pointing angles of each antenna. At this stage, the central processor, through an appropriate program containing all the data relevant to the territory covered by the network, calculates the orientation and the other best operation parameters of each antenna and determines possible differences between said best values and the values obtained from the above mentioned interrogation procedure.

[0021] These differences are corrected through sending, by the central processor, of appropriate orientation correction signals and/or of the other operation parameters to the peripheral processors 17, in order to change the form and/or the extent of the coverage fields 4 of the antennas 1 involved in this correction. In particular, this correction procedure includes the enabling in the peripheral processors 17 of a program reading the data transmitted by the central processor through the line 20 and correspondingly operated the threaded rods of the servomechanisms 13 and/or 15 of the antennas 1 to reposition. This program performs also, if necessary, the

modification of the other antenna operation parameters 1. Preferably, at the end of this correction procedure the peripheral processors 17 involved in the same, transmit the new values to the central processor as a confirmation of the corrections made. These values are stored in the memory of the central processor together with the current date and time.

[0022] It is evident that this system is adaptet not only to position the antennas of a mobile radio telephone network in the best way, but is can also re-position said antennas should a permanent or temporary modification occur, of the data relevant to the territory covered by the network. This modification can for instance be due to the failure of one or more antennas of a tower or to the sudden concentration of a high number of users in a given area of the territory.

[0023] In this case, the central processor of the system according to the present invention, being informed of the new situation through the data supplied by the outside, for instance from the base transceiver stations 5, geographical control stations 7 or mobile switching center 8, recalculates the best values of the orientation and of the other antenna operation parameters 1, transmitting then appropriate control signals to the peripheral processors 17 in order to adequate the real values to the best values, as explained before. It is evident that in other embodiments of the present invention the peripheral processors 17 and the central processor can be located in positions different from the base transceiver stations 5 and from the operating maintenance center 9, for instance in the geographical control stations 7, mobile switching center 8 or in other places.

[0024] It is also evident that the connection between the peripheral processors 17 and the central processor can take place through the same mobile radio telephone network controlled by the system according to the present invention.

[0025] It should be understood that the present invention is not limited thereto since other embodiments may be made by those skilled in the art without departing from the scope thereof.

Claims

1. System for the control of the antennas (1) of a mobile radio telephone network, which are installed on fixed bases (2) through a couple of supports (10, 11) rotating around a substantially horizontal axis and to a substantially vertical axis, respectively, in which the form and dimensions of the coverage area (4) of each antenna (1) depend on the vertical pointing angle (ϑ) and on the horizontal pointing angle (φ), characterized in that it includes at least one central electronic processor connected through bi-directional lines (20) to a plurality of peripheral electronic processors (17) connected in their turn through bi-directional lines to one or more servomechanisms (13, 15) installed on said fixed bases (2) in which the mobile component of one of said servomechanisms (13, 15) is cinematically coupled to one of said supports (10, 11) of the antennas (1) and is operated by an actuator according to electrical signals transmitted by said central electronic processor through said peripheral processors (17), said electrical signals corresponding to the variation of the vertical pointing angle (ϑ) and/or of the horizontal pointing angle (φ) of the antennas (1) themselves.

2. System according to the previous claim, characterised in that said servomechanisms (13, 15) include a digital sensor suitable to detect the position of the mobile component and to send the value corresponding to this position to said central electronic processor through said peripheral processors (17).

3. System according to one of the previous claims, characterised in that the mobile component of said servomechanisms (13, 15) includes a threaded rod that can be operated in longitudinal direction, whose free end is pivoted on one of the supports (10, 11) of the antennas (1).

4. System according to one of the previous claims, characterised in that said central processor transmits and receives through said peripheral processor (17) control signals and the values of the transmission power and width of the lobe of the antennas radiated field (1).

5. System according to one of the previous claims, characterised in that said peripheral processors (17) include a modem (19) that can be connected through switched or dedicated telephone lines (20) to another modem belonging to said central processor.

6. System according to one of the previous claims, characterised in that said peripheral processors (17) are placed in the base transceiver station (5) located close to each fixed base (2).

7. System according to one of the previous claims, characterised in that said central processor is placed in the operating maintenance center (9) of the mobile radio telephone network.

8. Process for the control of the antennas (1) of a mobile radio telephone network through a system according to one of the previous claims, characterized in that it includes the following operating steps:

   - Reading by the peripheral processors (17) of the position of the mobile components of each servomechanism (13, 15) through the relevant

digital sensors:

- sending of the values read by the peripheral processors (17) to the central processor through the bi-directional line (20);
- determination, on the basis of the initial values stored in the memory of the central processor, of vertical pointing angles (ϑ) and horizontal ones (φ) of each antenna (1);
- calculation of the best values of the orientation of each antenna (1) according to the data relevant to the territory covered by the mobile radio telephone network;
- determination of possible differences between the best values of the orientation of each antenna (1) and the values transmitted by the peripheral processors (17);
- sending of correction signals of said differences in the orientation of antennas (1) from the central processor to peripheral processors (17) through the bi-directional line (20), said signals corresponding to the variation of the vertical pointing angle (ϑ) and/or of the horizontal pointing angle (φ) of the antennas themselves;
- operation of the servomechanisms (13, 15) connected to the peripheral processors (17) according to said correction signals.

9. Proces according to claim 8 characterised in that it is started in response to the sending of a given interrogation code from the central processor to peripheral processors (17) through the bi-directional line (20).

10. Process according to claim 8, characterised in that it is started at predetermined time intervals.

11. Process according to claims 8 through 10, characterized in that it includes the following additional operating steps:

- reading by the peripheral processors (17) of the position of the mobile components of each servomechanism (13, 15) operated according to said correction signals;
- sending of the values read by the peripheral processors (17) to the central processor through the bi-directional line (20);
- storage of the values transmitted by the peripheral processors (17) in the memory of the central processor, together with the current date and time.

12. Process according to claim 8 or 11, characterized in that it includes the following additional operating steps:

- reading by the peripheral processors (17) of the antenna operation parameters (1);
- sending of the values read by the peripheral processors (17) to the central processor through the bi-directional line (20);
- calculation of the best operation parameters of each antenna (1) according to the data relevant to the territory covered by the mobile radio telephone network;
- determination of possible differences between the best values of the operation parameters of each antenna (1) and the values transmitted by the peripheral processors (17);
- sending of correction signals of these differences in the antenna operation parameters (1) from the central processor to the peripheral processors (17) through the bi-directional line (20).

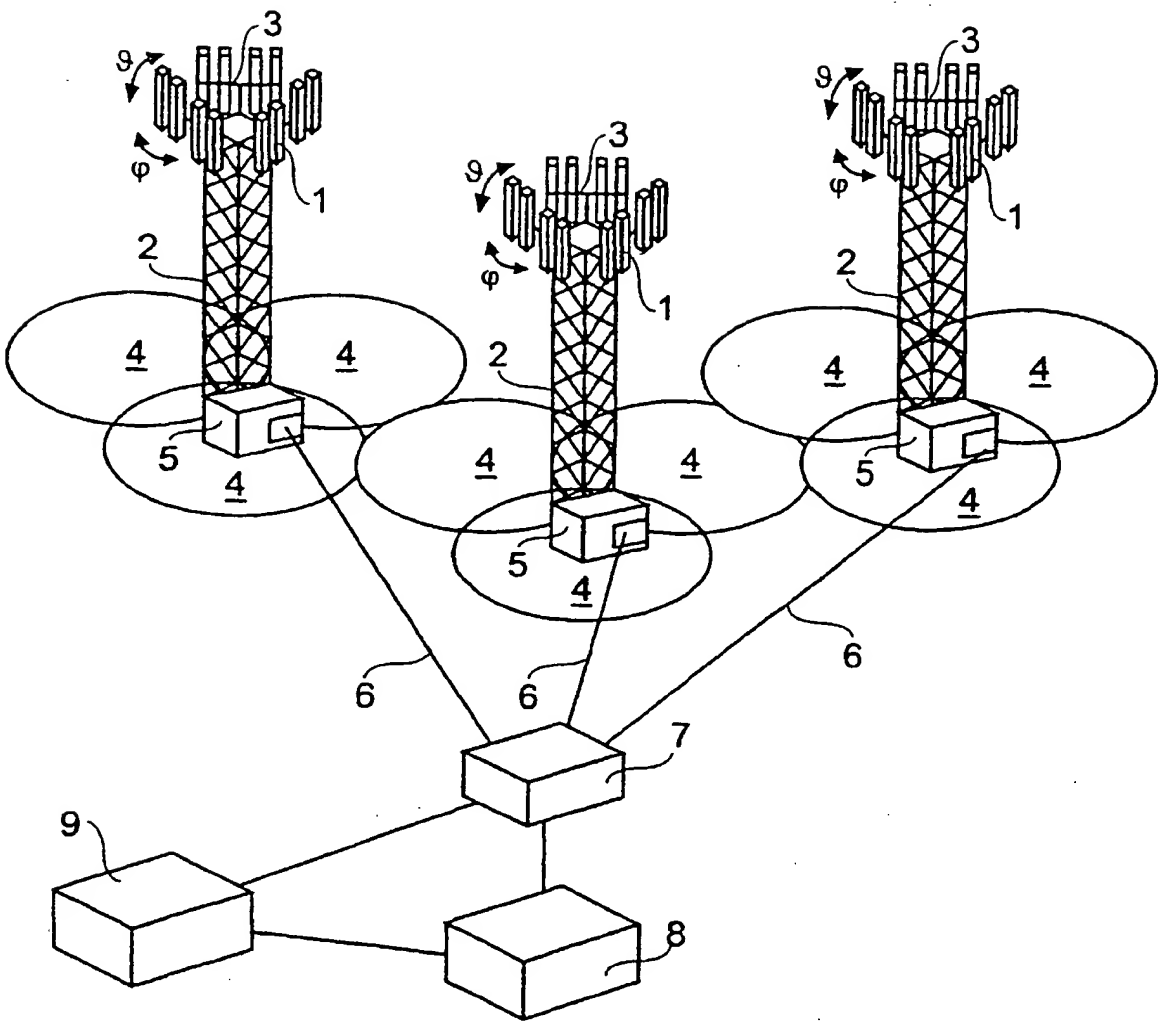

Fig.1

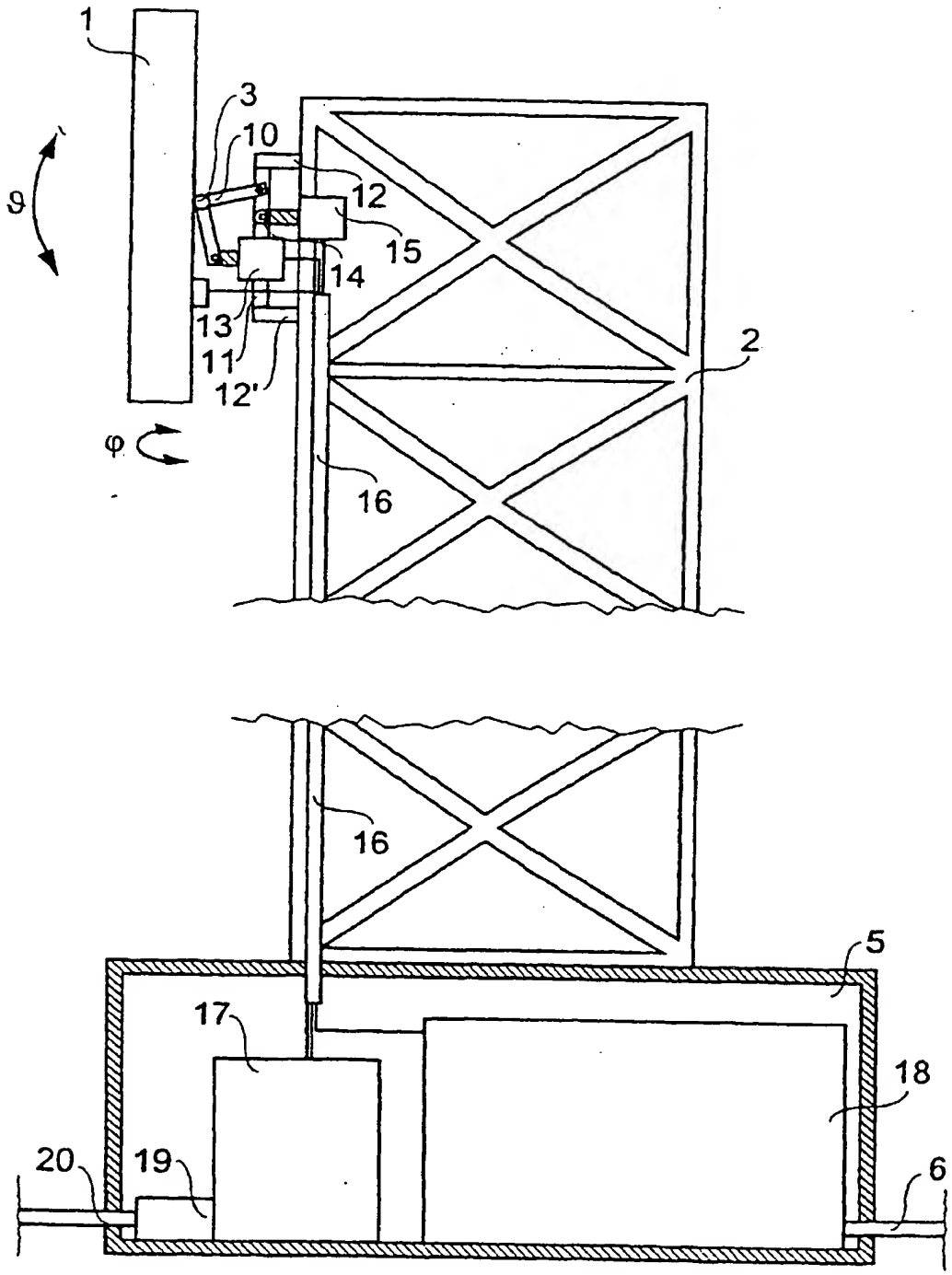

Fig.2